DELAWARE RIVER BASIN

TRIBUTARY TO CARLEY BROOK, WAYNE COUNTY

PENNSYLVANIA

# KELLOW LAKE DAM LEVEL II

**NDI ID NO. PA-01105**

**DER ID NO. 64-63**

## HONESDALE COUNTRY CLUB

## PHASE I INSPECTION REPORT
## NATIONAL DAM INSPECTION PROGRAM





Prepared by
GANNETT FLEMING CORDDRY AND CARPENTER, INC.
Consulting Engineers
Harrisburg, Pennsylvania 17105

"Original contains color plates: All DTIC reproductions will be in black and white"

For
**DEPARTMENT OF THE ARMY**
**Baltimore District, Corps of Engineers**
**Baltimore, Maryland 21203**

**JULY 1981**

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DACW31-81-C-0018

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# PREFACE

This report is prepared under guidance contained in Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigations, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

KELLOW LAKE DAM

NDI ID No. PA-01105; DER ID No. 64-63

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

CONTENTS



APPENDICES

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT OF GENERAL CONDITION

AND

RECOMMENDED ACTION

| | |
|---|---|
| Name of Dam: | Kellow Lake Dam<br>NDI ID No. PA-01105<br>DER ID No. 64-63 |
| Size: | Small (16 feet high; 582 acre-feet) |
| Hazard Classification: | High |
| Owner: | Honesdale Country Club<br>Edward H. Rothrock, President<br>515 Erie Heights<br>Honesdale, PA 18431 |
| State Located: | Pennsylvania |
| County Located: | Wayne |
| Stream: | Tributary to Carley Brook |
| Date of Inspection: | 3 June 1981 |

Based on available records, visual inspection, calculations, and past performance, Kellow Lake Dam is judged to be in fair condition. The recommended Spillway Design Flood (SDF) for the size and hazard classification of the dam varies between 1/2 of the Probable Maximum Flood (PMF) and the PMF. Based on the downstream conditions, the 1/2 PMF is selected as the SDF. Under existing conditions the spillway will pass only about 22 percent of the PMF. If all stoplogs were removed from the spillway, the spillway would pass about 51 percent of the PMF. The spillway capacity is rated as adequate provided that all stoplogs are removed.

Potential stability problems exist for the dam. A slope failure occurred over one reach at an unknown time in the past. Although the damage in that reach does not appear to be

serious, a similar failure could occur in a more critical area and threaten the overall stability of the dam. In addition, steel beams that support the roof of the spillway outlet channel are badly corroded and create a hazardous condition.

Although some maintenance has been performed, the program should be expanded to correct all deficiencies.

The following studies and remedial measures, listed in approximate order of priority, are recommended to be undertaken by the Owner without delay:

(1) Remove all stoplogs from the spillway. If pool levels higher than the spillway crest level are desired, perform studies and make modifications as required to ensure an adequate spillway capacity. The stoplogs should not be in place while any such studies are being performed.

(2) Install and monitor inclinometers or other instrumentation suitable for detecting any embankment movement. If any embankment movement occurs, take appropriate action as required. In lieu of an instrumentation program, perform investigations and studies as required to evaluate the stability of the dam. Take appropriate action as required.

(3) Design and construct measures as required to ensure the structural integrity of the dry stone masonry spillway outlet channel within the dam.

(4) Develop a method for drawing down the reservoir in case of an emergency. If a pipe is placed through the embankment, it should have an upstream closure facility.

(5) Remove all brush growing on the downstream slope of the dam and within 10 feet of the downstream toe.

(6) Visually monitor the wet area near the toe of the dam for any change in size, character, or discharge. Take appropriate action as required if any changes occur.

All investigations, studies, designs and inspection of construction should be performed by a professional engineer experienced in the design and construction of dams.

In addition, the Owner should institute the following operational and maintenance procedures:

(1) Develop a detailed emergency operation and warning system for Kellow Lake Dam. When warnings of a major storm are given by the National Weather Service, the Owner should activate the emergency operation and warning system.

(2) During periods of unusually heavy rains, provide round-the-clock surveillance of the dam.

(3) Initiate an inspection program such that the dam is inspected on a regular basis. As presently required by the Commonwealth, the inspection program should include a formal annual inspection by a professional engineer experienced in the design and construction of dams. Utilize the inspection results to determine if remedial measures are necessary.

KELLOW LAKE DAM

Submitted by:

GANNETT FLEMING CORDDRY
AND CARPENTER, INC.


FREDERICK FUTCHKO
Project Manager, Dam Section

Date: 7 August 1981

Approved by:

DEPARTMENT OF THE ARMY
BALTIMORE DISTRICT, CORPS OF
ENGINEERS

JAMES W. PECK
Colonel, Corps of Engineers
Commander and District Engineer

Date: 18 Aug 81

KELLOW LAKE DAM

Overview

KELLOW LAKE DAM

NDI ID No. PA-01105; DER ID No. 64-63

PHASE I INSPECTION REPORT

NATIONAL DAM INSPECTION PROGRAM

SECTION I

PROJECT INFORMATION

1.1 General.

a. Authority. The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. Kellow Lake Dam is an earthfill dam with a dry stone masonry facing on the downstream slope. The thickness of the dry stone masonry is not known. The dam is approximately 420 feet long and is 16.1 feet high. The average topwidth of the dam is 25 feet. The upstream slope is covered with dumped rock and has a slope of approximately 1V on 2H. The downstream slope is irregular, but has an average slope of approximately 1V on 1.4H.

The spillway is located near the center of the dam. A concrete approach channel leads from the reservoir to a drop inlet located near the axis of the dam. The approach channel narrows from a 7-foot width at its entrance to a 3.5-foot width at the drop inlet. The drop inlet is approximately 3.5 feet square. The entrance to the approach channel is at Elevation 1426.0. There are two sets of stoplog slots in the approach channel that can be used to regulate pool levels. Wooden stoplogs are used in both sets of slots. An outlet channel extends through the dam from the base of the drop inlet to the downstream toe. The channel is constructed of dry stone masonry with steel support beams.

There are no other outlet facilities at the dam. The various features of the dam are shown on the photographs in Appendix C and on the plates in Appendix E. A description of the geology is included in Appendix F.

b. Location. Kellow Lake Dam is located on a tributary to Carley Brook in Oregon Township, Wayne County, Pennsylvania. The dam is shown on USGS Quadrangle, Galilee, Pennsylvania, at latitude N 41° 38.1' and longitude W 75° 13.2'. Kellow Lake is identified as Upper Wilcox Pond on the USGS Quadrangle map. A location map is shown on Plate E-1.

c. Size Classification. Small (16.1 feet high, 582 acre-feet).

d. Hazard Classification. Downstream conditions indicate that a high hazard classification is warranted for Kellow Lake Dam (Paragraphs 3.1e and 5.1c).

e. Ownership. Honesdale Country Club, Edward H. Rothrock, President, 515 Erie Heights, Honesdale, PA 18431.

f. Purpose of Dam. Recreation.

g. Design and Construction History. Nothing is known about the design or construction of Kellow Lake Dam. Records indicate that it was probably constructed in the 1800's as part of the Delaware and Hudson Canal system. The only record of any modifications is correspondence indicating that the spillway was rehabilitated in 1978.

h. Normal Operational Procedure. The pool level is maintained at or above the spillway crest level (Elevation 1426.0). It was reported that the wooden stoplogs are removed in the late autumn and are inserted in the spring. It was reported that the pool is normally maintained 21 inches above spillway crest level during the recreational season, creating a pool level of Elevation 1427.8. However, on the date of the inspection, 29-inch high stoplogs were in place, creating a pool level of Elevation 1428.4.

1.3 Pertinent Data

| | | |
|---|---|---|
| a. | Drainage Area. (square miles) | 0.6 |
| b. | Discharge at Damsite. (cfs) | |
| | Maximum known flood | 1955 Flood, Discharge unknown |

b. Discharge at Damsite. (cfs) (cont'd.)

| | |
|---|---|
| Spillway capacity | |
| Existing conditions (Top of dam El. 1430.2) | |
| Stoplogs in place (29 inches high | 45 |
| Stoplogs removed | 93 |
| Design conditions (Top of dam El. 1431.6) | |
| Stoplogs in place (29 inches high) | 106 |

c. Elevation. (feet above msl.)

| | |
|---|---|
| Top of dam | |
| Existing | 1430.2 |
| Design | 1431.6 |
| Maximum pool | |
| Existing | 1430.2 |
| Design | 1431.6 |
| Normal pool | |
| Summer (with 29-inch stoplogs) | 1428.4 |
| Winter (spillway crest) | 1426.0 |
| Streambed at toe of dam | 1414.1 |

d. Reservoir Length. (miles)

| | |
|---|---|
| Winter pool (spillway crest level) | 0.56 |
| Maximum pool | 0.58 |

e. Storage. (acre-feet)

| | |
|---|---|
| Winter pool (spillway crest levels) | 278 |
| Summer pool (with 29-inch stoplogs) | 449 |
| Maximum pool | |
| Existing conditions | 582 |
| Design conditions | 688 |

f. Reservoir Surface. (acres)

| | |
|---|---|
| Winter pool (spillway crest level) | 70 |
| Maximum pool (approx.) | 76 |

g. Dam.

| | |
|---|---|
| Type | Earthfill with dry stone masonry facing on downstream slope |
| Length (feet) | 420 |
| Height (feet) | |
| Existing | 16.1 |
| Design | 17.5 |

g. Dam. (cont'd.)

| | |
|---|---|
| Topwidth (feet) | 25 |
| Side Slopes | |
| Upstream | IV on 2H |
| Downstream | Vary |
| Zoning | Unknown |
| Cutoff | Unknown |
| Grout Curtain | Unknown |

h. Diversion and Regulating Tunnel — None

i. Spillway.

| | |
|---|---|
| Type | Concrete-lined approach channel and drop inlet; Stoplogs used in approach channel |
| Lengths (feet) | |
| Entrance to spillway | 7 |
| Upstream stoplogs | 6 |
| Downstream stoplogs | 5 |
| Drop inlet throat | 3.5 |
| Elevations (feet above msl.) | |
| Entrance to spillway (spillway crest) | 1426.0 |
| Crest of upstream stoplogs | 1428.4 |
| Crest of downstream stoplogs | 1427.6 |
| Invert at throat of drop inlet | 1425.8 |
| Upstream Channel | Reservoir |
| Downstream Channel | Dry stone masonry to toe of dam; natural stream beyond |

j. Regulating Outlets. — None

## SECTION 2

## ENGINEERING DATA

2.1 Design.

a. Data Available. There are no design data available for Kellow Lake Dam.

b. Design Features. The project is described in Paragraph 1.2a. The various features of the dam are shown on the photographs in Appendix C and on Plate E-2.

c. Design Considerations. Design information for the dam is insufficient to assess the design of the dam.

2.2 Construction.

a. Data Available. There are no data available concerning the construction of the dam.

b. Construction Considerations. There are insufficient data to assess the construction of the dam.

2.3 Operation. There are no formal records of operation. Records of four inspections performed by the Commonwealth are available for the period from 1919 to 1972. A summary of the inspection reports is included in Appendix A.

2.4 Evaluation.

a. Availability. Engineering data were provided by the Bureau of Dams and Waterway Management, Department of Environmental Resources, Commonwealth of Pennsylvania (PennDER). A representative of the Owner was available for information during the visual inspection.

b. Adequacy. Engineering data for the dam are nearly nonexistent. The assessment of the dam must be based primarily on the visual inspection, performance history, hydrologic and hydraulic assumptions, and calculations developed for this report.

c. Validity. There is no reason to question the validity of the available data.

## SECTION 3

## VISUAL INSPECTION

### 3.1 Findings.

a. General. The overall appearance of the dam and appurtenant structures is fair. Noteworthy deficiencies observed are described in the following paragraphs. The complete visual inspection checklist and sketch of the dam are presented in Appendix B. A profile of the top of the dam is included in Appendix E. On the day of the inspection, the reservoir pool was at the top of the stoplogs, Elevation 1428.4.

b. Embankment. The upstream slope of the embankment is in good condition (Photograph A). The slope is protected by dumped rock having an average size of 3-4 inches. No erosion or sloughing of the slope has occurred. The top of the dam is covered with grass and is used as a driveway (Photograph A). The average topwidth of the dam is 25 feet. A survey of the top of the dam was performed, and it was found that the top elevation varies from Elevation 1430.2 to Elevation 1431.6. A profile along the top of the dam is shown on Plate E-2. For the purposes of this report, Elevation 1431.6 was selected as the design level for the top of the dam because it is the elevation of the top of the spillway structures. There are six large trees growing on the top of the dam over about a 120-foot reach at the left abutment (Photograph B). In this reach, the maximum height of the dam is only about 4 feet. The downstream slope of the dam is covered with dry stone masonry (Photographs C to F). There is a short reach of vertical dry stone masonry near the left abutment (Photograph B), but the remainder of the dry stone masonry has a batter. The slope is somewhat irregular but has an average value of 1V on 1.4H at the highest section of the dam. A section in that area is shown on Plate E-2 and on Photograph C. From the left abutment to a point located about 50 feet right of the spillway, a length of about 210 feet, the dry stone masonry is generally in good condition (Photograph C). However, beginning about 50 feet right of the spillway and extending about 90 feet toward the right abutment, there is an area where it is evident that a slope failure occurred. The slope of the dry stone masonry in this reach is somewhat flatter than in other areas, it is very irregular, and there is a bulge along the toe. The intact dry stone masonry adjoining the slide area is warped. In the slide area, the original form of the stone masonry construction has largely been lost. The slide area is shown on Photographs D, E and F. At the top of the slope in this reach, there appears to be evidence of an

old scarp. Although the scarp is now rounded and covered with vegetation, it appears that a narrow portion of the top of the dam might have dropped about one foot. Vegetation growing over the area, the absence of any visible cracks or fresh surfaces, and information from the Owner's representative all indicate that the slide is not recent. The presence of vegetation and brush over most of the downstream slope prevented detailed inspection of the area. One wet area exists near the downstream toe of the dam. The wet area is located about 15 feet left of the stream channel and about 25 feet from the toe of the dam. A slight clear flow of water seeps from the wet area.

c. Appurtenant Structures. The concrete portions of the spillway are in good condition (Photograph G). The approach channel leads from the reservoir to a drop inlet located near the axis of the dam. The approach channel has slots for two sets of stoplogs. On the date of the inspection, the pool level was regulated by 29-inch high wooden stoplogs in the upstream set of slots, creating a pool level at Elevation 1428.4. There is a dry stone masonry outlet channel that leads from the bottom of the drop inlet to the toe of the dam. About one-half of the length of the channel is fully enclosed by dry stone masonry (Photograph H). The roof of this reach is supported by steel beams that span the channel. Most of the beams are badly corroded. A large stone at the roof at the downstream end of the enclosed section has a crack through its center that runs the full length of the stone. There are no other outlet facilities at the dam.

d. Reservoir Area. The watershed is about 60 percent wooded and about 40 percent farmland. The hills in the watershed rise to a maximum of 160 feet above the level of the reservoir and are gently to moderately sloped. The USGS topographic map shows two points of outflow from Kellow Lake. The first point is on the western end of the lake at the dam, and the second is at the south end of the lake. Field checking for this inspection showed that the map is in error and that the only outlet from Kellow Lake is at the dam.

e. Downstream Conditions. The valley immediately downstream from the dam is narrow and relatively steep. The stream flows under a bridge about 0.5 mile downstream from the dam. The top of the roadway at the bridge was estimated to be about 7 feet above the streambed. There is a mobile home adjacent to and situated about 7 feet above the bridge. The stream flows under Carley Brook Road about 200 feet further downstream. About 400 feet beyond Carley Brook Road there is a multiple unit dwelling situated immediately adjacent to and about 6 feet above the streambed. About 0.65 mile downstream from the dam, the stream joins Carley Brook. No dwellings are

located in the potential floodplain along the next 3.2 miles of Carley Brook. Bunnell's Pond Dam is located 3.9 miles downstream from Kellow Lake Dam. Bunnell's Pond Dam, DER ID No. 64-29, was inspected previously and is a high hazard dam. Bunnell's Pond Dam has 179 acre-feet of available surcharge storage, compared to the 582 acre-feet of storage in Kellow Lake Dam. Based on inspection of the downstream conditions, it was judged that failure of Kellow Lake Dam could cause loss of more than a few lives. Accordingly, a high hazard classification has been assigned to Kellow Lake Dam.

## SECTION 4

## OPERATIONAL PROCEDURES

4.1 Procedure. Pool levels are regulated by using wooden stoplogs in the spillway approach channel. It was reported to the inspection team that all stoplogs are removed in the late autumn, resulting in a winter pool level at Elevation 1426.0. It was reported that the pool is normally maintained 21 inches above spillway crest level, resulting in a pool level at Elevation 1427.8, throughout the recreational season. However, on the date of inspection, 29-inch high stoplogs were in place, creating a pool level at Elevation 1428.4.

4.2 Maintenance of Dam. Maintenance of the dam is performed whenever it is deemed to be needed. The overall condition of the dam is observed at least on a weekly basis, and a committee is responsible for evaluating maintenance requirements.

4.3 Maintenance of Operating Facilities. The only operating facilities at the dam are the stoplogs, which are in good condition.

4.4 Warning Systems in Effect. There is no emergency operation and warning system for the dam.

4.5 Evaluation of Operational Adequacy. Maintenance of the dam has been fair, but the inspection disclosed deficiencies that require attention. More detailed inspections than are currently performed are necessary to detect hazardous conditions at the dam. Because the ability of the dam to withstand floods is highly dependent on the pool level being maintained, strict operating procedures should be developed and documented. An emergency operation and warning system is necessary to reduce the risk of dam failure should adverse conditions develop and to prevent loss of life should the dam fail.

## SECTION 5

## HYDROLOGY AND HYDRAULICS

### 5.1 Evaluation of Features.

a. Design Data. There are no hydrologic or hydraulic design calculations available for Kellow Lake Dam. Spillway repairs were made in 1978, but the work reportedly was limited to rehabilitation of the structure.

b. Experience Data. Major floods occurred in the area in 1942 and 1955. The discharges at the damsite for these floods are not known, but it is reported that the dam was not overtopped by either flood.

c. Visual Observations.

(1) General. The visual inspection of Kellow Lake Dam, which is described in Section 3, resulted in a number of observations relevant to hydrology and hydraulics.

(2) Embankment. The top of the embankment is irregular, having an elevation difference of 1.4 feet between the lowest point and the highest point. Under existing conditions, overtopping of the dam would begin at Elevation 1430.2. As used in this report, the design level for the dam was selected as the top of the spillway structure at the axis of the dam, Elevation 1431.6. Substantial increase in safety against overtopping would exist if the entire top of dam were at the design level.

(3) Appurtenant Structures. Nothing was observed that would indicate that the spillway would not operate satisfactorily in the event of a flood. The fact that the spillway is very small and that pool levels are regulated by stoplogs create several areas of concern. First, the ability of the dam to withstand large floods without overtopping is very sensitive to the pool level at the start of the flood. A stoplog system is adequate only if strict operating rules consistent with dam safety are in effect. Second, the small spillway substantially limits the effects of removing the stoplogs after the start of a flood. A substantial reduction in the risk of overtopping would only result if the pool were lowered before the start of floodflows.

There are no facilities at the dam for drawing down the pool level. If an emergency condition were to develop, there would be no means available for reducing the risk of failure.

(4) Reservoir Area. Nothing was noted in the watershed area that would have unusual effects on floodflows.

(5) Downstream Conditions. The downstream conditions are described in Paragraph 3.1e. It is judged that failure of the dam could result in flooding of the mobile home and the multiple-unit dwelling located about one-half mile downstream from the dam. Failure of Kellow Lake Dam could also contribute to conditions leading to a failure of Bunnell's Pond Dam, located 3.9 miles downstream. It is estimated that more than a few lives could be lost if Kellow Lake Dam were to fail. As a result, a high hazard classification is warranted for the dam.

d. Overtopping Potential.

(1) Spillway Design Flood. According to the criteria established by the Office of the Chief of Engineers (OCE), the Spillway Design Flood (SDF) for the size (small) and hazard potential (high) of Kellow Lake Dam is between one-half of the Probable Maximum Flood (PMF) and the PMF. Based on the small height of the dam and the downstream conditions, the 1/2 PMF was selected as the SDF for Kellow Lake Dam. The watershed and reservoir were modeled with the U.S. Army Corps of Engineers' HEC-1DB computer program. A description of this computer program is included in Appendix D. The assessment of the hydrology and hydraulics is based on existing conditions, without consideration of the effects of future development.

(2) Summary of Results. Because of the nature of the spillway configuration, analyses were performed for three cases. The first case considered was for the conditions that existed on the date of the inspection, which were top of dam at Elevation 1430.2 and the pool level at Elevation 1428.4 (29-inch high stoplogs in place). Under these conditions, Kellow Lake Dam can pass about 22 percent of the PMF before overtopping of the dam occurs. The second case was for a uniform top of dam level at Elevation 1431.6 (design level) and the pool level at Elevation 1428.4. Under these conditions, Kellow Lake Dam can pass about 42 percent of the PMF before overtopping of the dam occurs. The third case evaluated the maximum spillway capacity that can be obtained with the existing top of dam condition (top of dam at Elevation 1430.2) and with all the stoplogs removed. With all the stoplogs removed, Kellow Lake Dam can pass about 51 percent of the PMF before overtopping of the dam occurs.

(3) Spillway Adequacy. The cases analyzed above are only a few of several combinations of conditions that could be considered. They are sufficient, however, to evaluate the spillway adequacy. The criteria used to rate the spillway adequacy are described in Appendix D. Under existing conditions, the spillway capacity is about 22 percent and it is inadequate. If the dam were filled to its design elevation and the 29-inch high stoplogs were left in place, the spillway capacity would be about 42 percent and it would still be inadequate. If all stoplogs were removed, with top of dam at its existing elevation, the spillway capacity would be 51 percent and it would be adequate. Since there exists a case whose conditions can be achieved simply by removing all stoplogs, the spillway capacity is rated as adequate provided that the stoplogs are removed.

## SECTION 6

## STRUCTURAL STABILITY

### 6.1 Evaluation of Structural Stability.

a. Visual Observations.

(1) General. The visual inspection of Kellow Lake Dam, which is described in Section 3, resulted in a number of observations relevant to structural stability. These observations are evaluated herein for the various features.

(2) Embankment. The trees growing on the top of the dam near the left abutment are undesirable but do not greatly affect the safety of the dam. If they should blow over, they might cause damage to the embankment. However, the embankment in that area is about 25 feet wide and has an average height of about 3 feet; and since the trees are located near the downstream edge of the top of the dam, the damage that might result probably would not be critical.

The brush growing on the downstream slope and along the downstream toe hinders inspection and could prevent detection of hazardous conditions.

The wet area located downstream from the toe of the dam near the left abutment does not appear to be a serious condition at the present time, but it should be monitored for change.

The area on the embankment where a slide occurred sometime in the past is the greatest item of concern with respect to the structural stability of the dam. Although the substantial topwidth prevented the slide from seriously threatening the dam, there is concern that a similar failure might occur in a more critical location, such as at the section where the spillway is located. A similar failure in that area could result in a serious threat to stability of the dam.

(3) Appurtenant Structures. The badly corroded steel beams that support the roof of the spillway outlet channel within the dam are hazardous to the stability of the dam. A collapse in that area could occur which, when coupled with flow from the spillway, could result in a serious threat to the stability of the dam.

b. Design and Construction Data. No stability calculations or records of construction are available.

c. Operating Records. There are no operating records maintained for Kellow Lake Dam. There is no information available that gives any indication of when the slope failure occurred.

d. Post-construction Changes. The known modifications to the dam have not adversely affected the structural stability of the dam.

e. Seismic Stability. Kellow Lake Dam is located in Seismic Zone 1 where earthquake loadings are not considered to be significant for small dams with no readily apparent stability problems. However, since there are concerns about the static stability of the dam, the seismic stability of the dam cannot be assumed to be adequate.

# SECTION 7

# ASSESSMENT, RECOMMENDATIONS, AND PROPOSED REMEDIAL MEASURES

## 7.1 Dam Assessment.

### a. Safety.

(1) Based on available records, visual inspection, calculations, and past performance, Kellow Lake Dam is judged to be in fair condition. Considering the size and hazard classification of the dam, the recommended SDF ranges from the 1/2 PMF to the PMF. Based on the size of the dam and the downstream conditions, the 1/2 PMF was selected as the SDF. Under existing conditions, the spillway will pass approximately 22 percent of the PMF before overtopping of the dam occurs. Under existing conditions the spillway capacity is inadequate. If all stoplogs were removed from the spillway, the spillway would pass about 51 percent of the PMF. Therefore, the spillway capacity is rated as adequate provided that all stoplogs are removed.

(2) Potential stability problems exist for the dam. A slope failure occurred over one reach at an unknown time in the past. Although the damage in that reach does not appear to be serious, a similar failure could occur in a more critical area and threaten the overall stability of the dam. In addition, steel beams that support the roof of the spillway outlet channel are badly corroded and create a hazardous condition

(3) Although some maintenance has been performed, the program should be expanded to correct all deficiencies.

(4) A summary of the features and observed deficiencies is as follows:

| Feature | Observed Deficiency |
|---|---|
| Embankment: | Top elevation varies; trees growing on top; slope failure over one reach; brush on downstream slope; one wet area near toe. |
| Spillway: | Roof support beams in outlet channel corroded. |
| Outlet Works: | None; no means available for drawing down the pool level. |

b. Adequacy of Information. The information available is such that an assessment of the condition of the dam can be inferred from the combination of available data, visual inspection, past performance, and computations performed as part of this study.

c. Urgency. The recommendations in Paragraph 7.2 should be implemented without delay.

d. Necessity for Futher Investigations. In order to accomplish the remedial measures outlined in Paragraph 7.2, further investigations by the Owner will be required.

7.2 Recommendations and Remedial Measures.

a. The following studies and remedial measures, listed in approximate order of priority, are recommended to be undertaken by the Owner without delay:

(1) Remove all stoplogs from the spillway. If pool levels higher than the spillway crest level are desired, perform studies and make modifications as required to ensure an adequate spillway capacity. The stoplogs should not be in place while any such studies are being performed.

(2) Install and monitor inclinometers or other instrumentation suitable for detecting any embankment movement. If any embankment movement occurs, take appropriate action as required. In lieu of the instrumentation program, perform investigations and studies as required to evaluate the stability of the dam. Take appropriate action as required.

(3) Design and construct measures as required to ensure the structural integrity of the dry stone masonry spillway outlet channel within the dam.

(4) Develop a method for drawing down the reservoir in case of an emergency. If a pipe is placed through the embankment, it should have an upstream closure facility.

(5) Remove all brush growing on the downstream slope of the dam and within 10 feet of the downstream toe.

(6) Visually monitor the wet area near the toe of the dam for any change in size, character, or discharge. Take appropriate action as required if any changes occur.

All investigations, studies, designs and inspection of construction should be performed by a professional engineer experienced in the design and construction of dams.

b. In addition, the Owner should institute the following operational and maintenance procedures:

(1) Develop a detailed emergency operation and warning system for Kellow Lake Dam. When warnings of a major storm are given by the National Weather Service, the Owner should activate the emergency operation and warning system.

(2) During periods of unusually heavy rains, provide round-the-clock surveillance of the dam.

(3) Initiate an inspection program such that the dam is inspected on a regular basis. As presently required by the Commonwealth, the inspection program should include a formal annual inspection by a professional engineer experienced in the design and construction of dams. Utilize the inspection results to determine if remedial measures are necessary.

# APPENDIX A

# CHECKLIST - ENGINEERING DATA

CHECKLIST

ENGINEERING DATA

DESIGN, CONSTRUCTION, AND OPERATION
PHASE I

NAME OF DAM: Kellow Lake Dam

NDI ID NO.: PA-01105 DER ID NO.: 64-63

Sheet 1 of 4

| ITEM | REMARKS |
|---|---|
| AS-BUILT DRAWINGS | None - See Sketch of Dam on Plate E-2. |
| REGIONAL VICINITY MAP | See Location Map on Plate E-1. |
| CONSTRUCTION HISTORY | Original date of construction unknown. Reported to be part of Delaware and Hudson Canal system. Spillway repaired in 1978. |
| TYPICAL SECTIONS OF DAM | See Plate E-2. |
| OUTLETS:<br>Plan<br>Details<br>Constraints<br>Discharge Ratings | No outlets other than spillway. |

A-1

ENGINEERING DATA



| ITEM | REMARKS |
|---|---|
| RAINFALL/RESERVOIR RECORDS | None available. |
| DESIGN REPORTS | None available. |
| GEOLOGY REPORTS | None available. For general geologic description see Appendix F. |
| DESIGN COMPUTATIONS:<br>Hydrology and Hydraulics<br>Dam Stability<br>Seepage Studies | None available. |
| MATERIALS INVESTIGATIONS:<br>Boring Records<br>Laboratory<br>Field | None available. |
| POSTCONSTRUCTION SURVEYS OF DAM | None. |

ENGINEERING DATA



| ITEM | REMARKS |
|---|---|
| BORROW SOURCES | Unknown. |
| MONITORING SYSTEMS | None. |
| MODIFICATIONS | Spillway repaired in 1978. |
| HIGH POOL RECORDS | None. |
| POSTCONSTRUCTION ENGINEERING STUDIES AND REPORTS | None. |
| PRIOR ACCIDENTS OR FAILURE OF DAM:<br>Description<br>Reports | None reported in records. |

ENGINEERING DATA



| ITEM | REMARKS |
|---|---|
| MAINTENANCE AND OPERATION RECORDS | None. |
| SPILLWAY:<br>Plan<br>Sections<br>Details | See spillway sketch in Appendix D. |
| OPERATING EQUIPMENT:<br>Plans<br>Details | No operating equipment. |
| PREVIOUS INSPECTIONS<br>Dates<br>Deficiencies | 1919 - Reported to be in fair condition.<br>1942 - Not damaged by 1942 Flood; covered with brush and weeds.<br>1946 - Covered with trees and brush.<br>1972 - Spillway concrete deteriorated |
| | |

# APPENDIX B

# CHECKLIST - VISUAL INSPECTION

CHECKLIST

VISUAL INSPECTION

PHASE I

Name of Dam: Kellow Lake Dam County: Wayne State: Pennsylvania

NDI ID No.: PA-01105 DER ID No.: 64-63

Type of Dam: Earthfill and dry stone masonry Hazard Category: High

Date(s) Inspection: 3 June 1981 Weather: Overcast Temperature: 65°

2.4-foot high staplogs in place on date of inspection

Pool Elevation at Time of Inspection: 1428.4 msl/Tailwater at Time of Inspection: 1414.5 msl

Inspection Personnel:

D.B. Wilson (GFCC) E. Rothrock (President, Honesdale Country Club)

A.M. Whitman (GFCC) _____ _____

O.R. Ebersole (GFCC) _____ _____

D.B. Wilson (GFCC) Recorder

## EMBANKMENT

Sheet 1 of 2

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| SURFACE CRACKS | None apparent. | |
| UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE | Bulge at downstream toe and deformed downstream slope from 50' rt. of spillway to approx. 100' from rt. end of dam. | Vague indications of scarp at top of slope; probable slope failure at some time in past; no signs of active movement. |
| SLOUGHING OR EROSION:<br>Embankment Slopes<br>Abutment Slopes | Abutment slopes - none.<br>Upstream slope - none visible.<br>Downstream slope - irregular; possibly some bulging. | Should monitor dam for future movement. |
| CREST ALIGNMENT:<br>Vertical<br>Horizontal | Horizontal - no deficiencies.<br>Vertical - irregular - see top of dam profile on Plate E-2. | Top of dam should be filled to design level. |
| RIPRAP FAILURES | None - upstream slope covered with 3"-4" stone in good condition. | |

## EMBANKMENT

Sheet 2 of 2

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| JUNCTION OF EMBANKMENT WITH:<br>Abutment<br>Spillway<br>Other Features | No deficiencies. | |
| ANY NOTICEABLE SEEPAGE | Wet area approx. 10'x20' with slight clear flow located 15' left of spillway and 25' from downstream toe. | Wet area could be natural drainage or seepage. Should be monitored. |
| STAFF GAGE AND RECORDER | None. | |
| DRAINS | None. | |
| BRUSH / TREES | Brush on downstream slope and along toe. Six trees on top dam from left abutment to 120' from left abutment. | Recommend removing brush. Trees are minor because height of dam over reach does not exceed about 4 feet |

## OUTLET WORKS

Sheet 1 of 1

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT | N/A | |
| INTAKE STRUCTURE | N/A | |
| OUTLET STRUCTURE | N/A | |
| OUTLET CHANNEL | N/A | |
| EMERGENCY GATE | N/A | |

UNGATED SPILLWAY

Sheet 1 of 1

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| CONCRETE WEIR | No weir - concrete approach channel with drop inlet located near axis of dam. | |
| APPROACH CHANNEL | Concrete approach channel in good condition. | Two sets of stoplogs in channel. Upstream set 29" high; Downstream set 20" high. |
| DISCHARGE CHANNEL | Dry stone masonry outlet structure through dam and natural channel beyond. | Steel support beams for dry stone masonry badly corroded. Recommend repairs to prevent possible collapse. |
| BRIDGE AND PIERS | None. | |
| | | |

## INSTRUMENTATION

Sheet 1 of 1

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| MONUMENTATION/SURVEYS | None. | |
| OBSERVATION WELLS | None. | |
| WEIRS | None. | |
| PIEZOMETERS | None. | |
| OTHER | None. | |

## DOWNSTREAM CHANNEL

Sheet 1 of 1

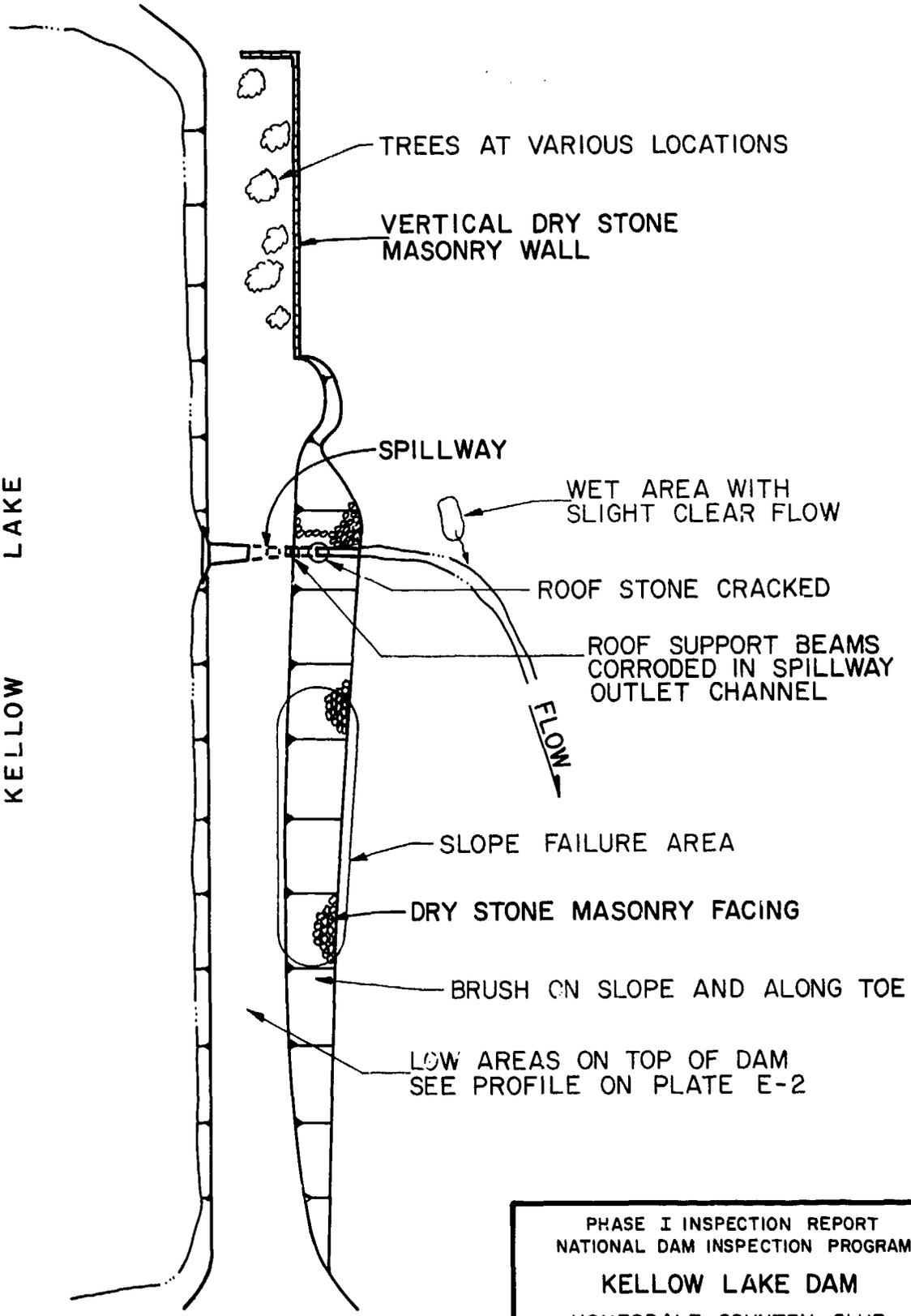
| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| CONDITION:<br>Obstructions<br>Debris<br>Other | No obstructions that would affect spillway capacity or cause significant tailwater. | |
| SLOPES | Slopes vary. No indications of stability problems. | |
| APPROXIMATE NUMBER OF HOMES AND POPULATION | One trailer and one multiple unit dwelling located 0.5 mile downstream. Bunnell's Pond Dam located 3.9 miles D.S. | |
| | | |
| | | |

## RESERVOIR AND WATERSHED

Sheet 1 of 1

| VISUAL EXAMINATION OF | OBSERVATIONS | REMARKS OR RECOMMENDATIONS |
|---|---|---|
| SLOPES | Generally mild and wooded in vicinity of reservoir. | |
| SEDIMENTATION | None reported. | |
| WATERSHED DESCRIPTION | Approx. 60% wooded; mostly undeveloped. | |
| | | |
| | | |

DATE OF INSPECTION: 3 JUNE 1981
POOL ELEVATION : 1428.4




NOT TO SCALE

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

KELLOW LAKE DAM

HONESDALE COUNTRY CLUB

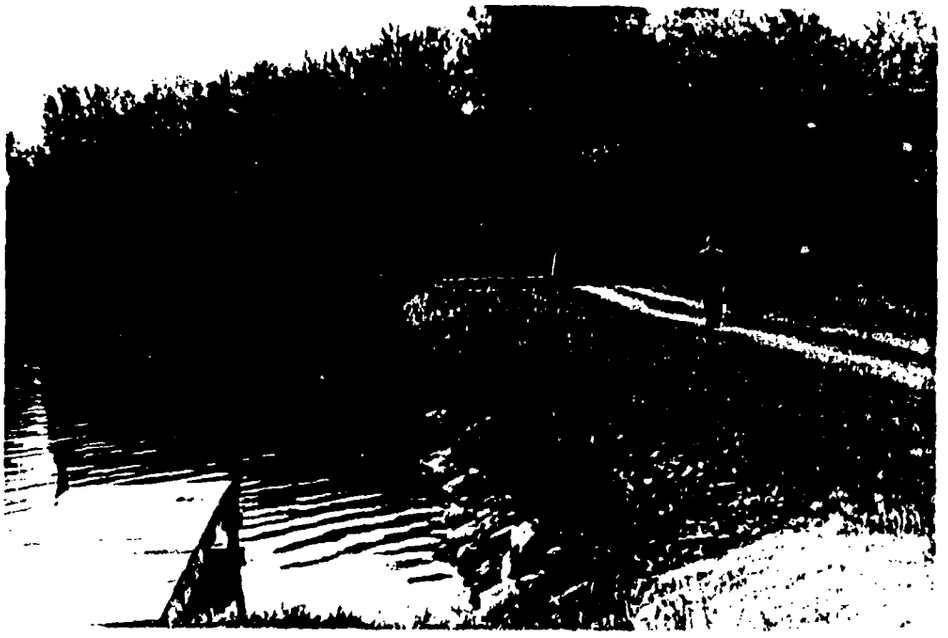
**RESULTS OF VISUAL INSPECTION**

JULY 1981 EXHIBIT B-1

# APPENDIX C

# PHOTOGRAPHS

KELLOW LAKE DAM



A. Upstream Slope and Top of Dam

B. Downstream Side of Dam at Left Abutment

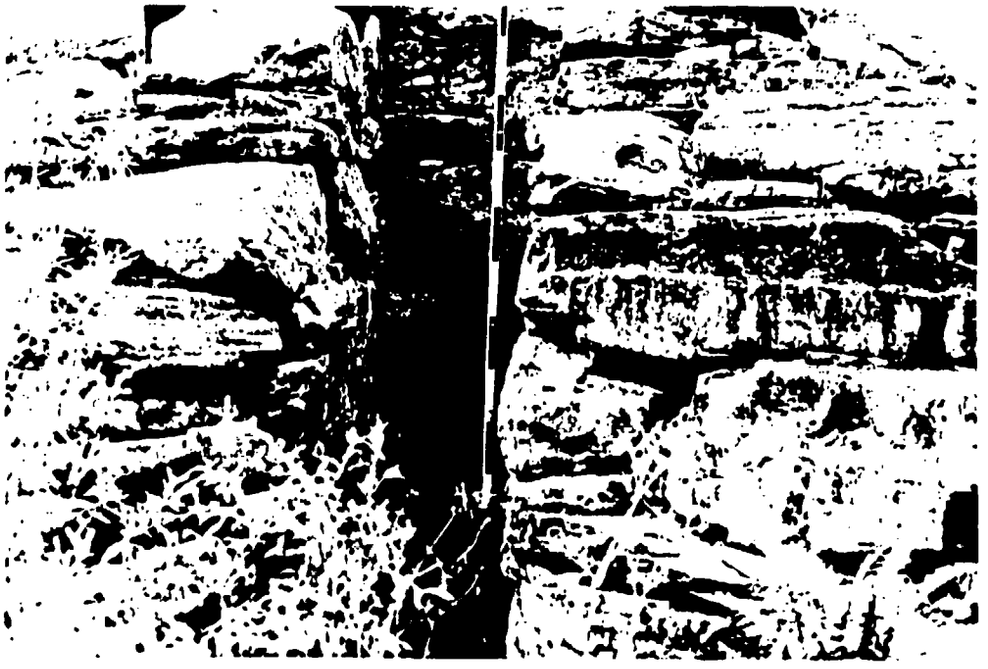
C. Downstream Slope of Dam At Spillway

D. Distortions of Dry Stone Masonry on Downstream Slope of Dam at Edge of Slide Area

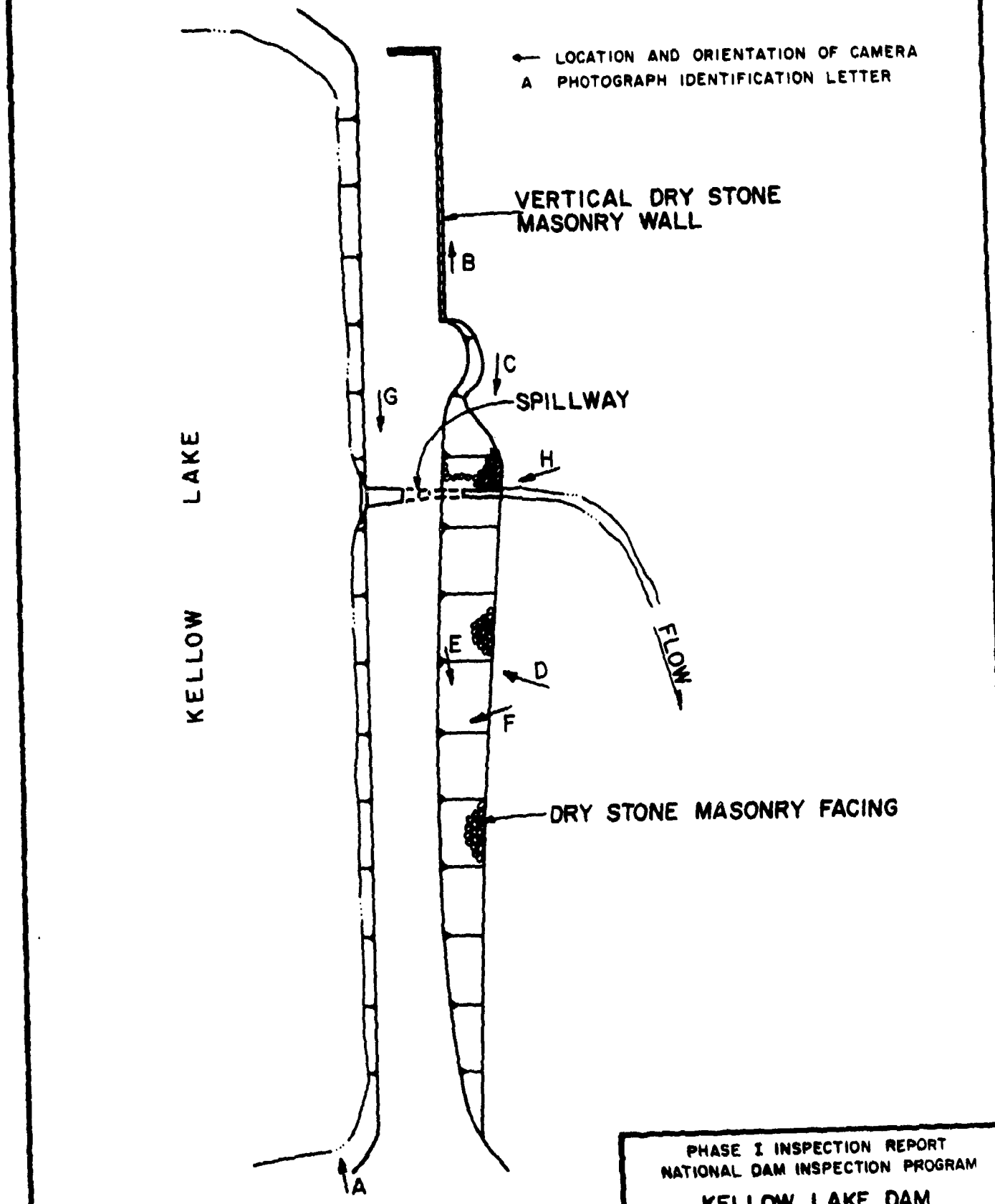
E. Downstream Slope at Slide Area

F. Downstream Slope at Slide Area

G. Spillway



H. Spillway Outlet Channel Through Dam




PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

KELLOW LAKE DAM

HONESDALE COUNTRY CLUB

GUIDE TO LOCATION OF PHOTOGRAPHS

JULY 1981 EXHIBIT C-1

# APPENDIX D

# HYDROLOGY AND HYDRAULICS

# APPENDIX D

## HYDROLOGY AND HYDRAULICS

Spillway Capacity Rating:

In the recommended Guidelines for Safety Inspection of Dams, the Department of the Army, Office of the Chief of Engineers (OCE), established criteria for rating the capacity of spillways. The recommended Spillway Design Flood (SDF) for the size (small, intermediate, or large) and hazard potential (low, significant, or high) classification of a dam is selected in accordance with the criteria. The SDF for those dams in the high hazard category varies between one-half of the Probable Maximum Flood (PMF) and the PMF. If the dam and spillway are not capable of passing the SDF without overtopping failure, the spillway capacity is rated as inadequate. If the dam and spillway are capable of passing one-half of the PMF without overtopping failure, or if the dam is not in the high hazard category, the spillway capacity is not rated as seriously inadequate. A spillway capacity is rated as seriously inadequate if all of the following conditions exist:

(a) There is a high hazard to loss of life from large flows downstream of the dam.

(b) Dam failure resulting from overtopping would significantly increase the hazard to loss of life downstream from the dam from that which would exist just before overtopping failure.

(c) The dam and spillway are not capable of passing one-half of the PMF without overtopping failure.

Description of Model:

If the Owner has not developed a PMF for the dam, the watershed is modeled with the HEC-1DB computer program, which was developed by the U.S. Army Corps of Engineers. The HEC-1DB computer program calculates a PMF runoff hydrograph (and percentages thereof) and routes the flows through both reservoirs and stream sections. In addition, it has the capability to simulate an overtopping dam failure. By modifying the rainfall criteria, it is also possible to model the 100-year flood with the program.

# APPENDIX D

DELAWARE River Basin
Name of Stream: TRIBUTARY TO CARLEY BROOK
Name of Dam: KELLOW LAKE DAM
NDI ID No.: PA-01105
DER ID No.: 64-63
Latitude: N 41° 38.1' Longitude: W 073° 13.2'
Top of Dam Elevation: 1430.2
Streambed Elevation: 1414.1 Height of Dam: 16.1 ft
Reservoir Storage at Top of Dam Elevation: 582 acre-ft
Size Category: SMALL
Hazard Category: HIGH (see Section 5)
Spillway Design Flood: RECOMMENDED SDF VARIES FROM ½ PMF TO PMF
SELECT ½ PMF BASED ON DOWNSTREAM CONDITIONS

## UPSTREAM DAMS - NONE

| Name | Distance from Dam (miles) | Height (ft) | Storage at top of Dam Elevation (acre-ft) | Remarks |
|---|---|---|---|---|
| | | | | |
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## DOWNSTREAM DAMS

| | | | | |
|---|---|---|---|---|
| BUNNELL'S POND | 3.9 | 17 | 339 | DER ID 64-29 |
| FREETHY | 5.2 | 26 | 89 | DER ID 64-160 |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

DELAWARE River Basin

Name of Stream: TRIBUTARY TO CARLEY BROOK

Name of Dam: KELLOW LAKE DAM

DETERMINATION OF PMF RAINFALL & UNIT HYDROGRAPH

UNIT HYDROGRAPH DATA:

| Sub-area | Drainage Area (square miles) | Cp (1) | Ct (2) | L miles (3) | $L_{ca}$ miles (4) | L' miles (5) | Tp hours (6) | Map Area (7) | Plate (8) |
|---|---|---|---|---|---|---|---|---|---|
| A-1 | 0.60 | 0.45 | 1.23 | N/A | N/A | 0.51 | 0.82 | 1 | A |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |
| Total | 0.60 | | | | | | | | |

(See Sketch on Sheet D-4)

(1) & (2): Snyder Unit Hydrograph coefficients supplied by Baltimore District, Corps of Engineers on maps and plates referenced in (7) & (8)

The following are measured from the outlet of the subarea:

(3): Length of main watercourse extended to divide

(4): Length of main watercourse to the centroid

The following is measured from the upstream end of the reservoir at normal pool:

(5): Length of main watercourse extended to divide

(6): $Tp=C_t \times (L \times L_{ca})^{0.3}$, except where the centroid of the subarea is located in the reservoir. Then $Tp=C_t \times (L')^{0.6}$

Initial flow is assumed at 1.5 cfs/sq. mile

Computer Data: QRCSN = -0.05 (5% of peak flow)

RTIOR = 2.0

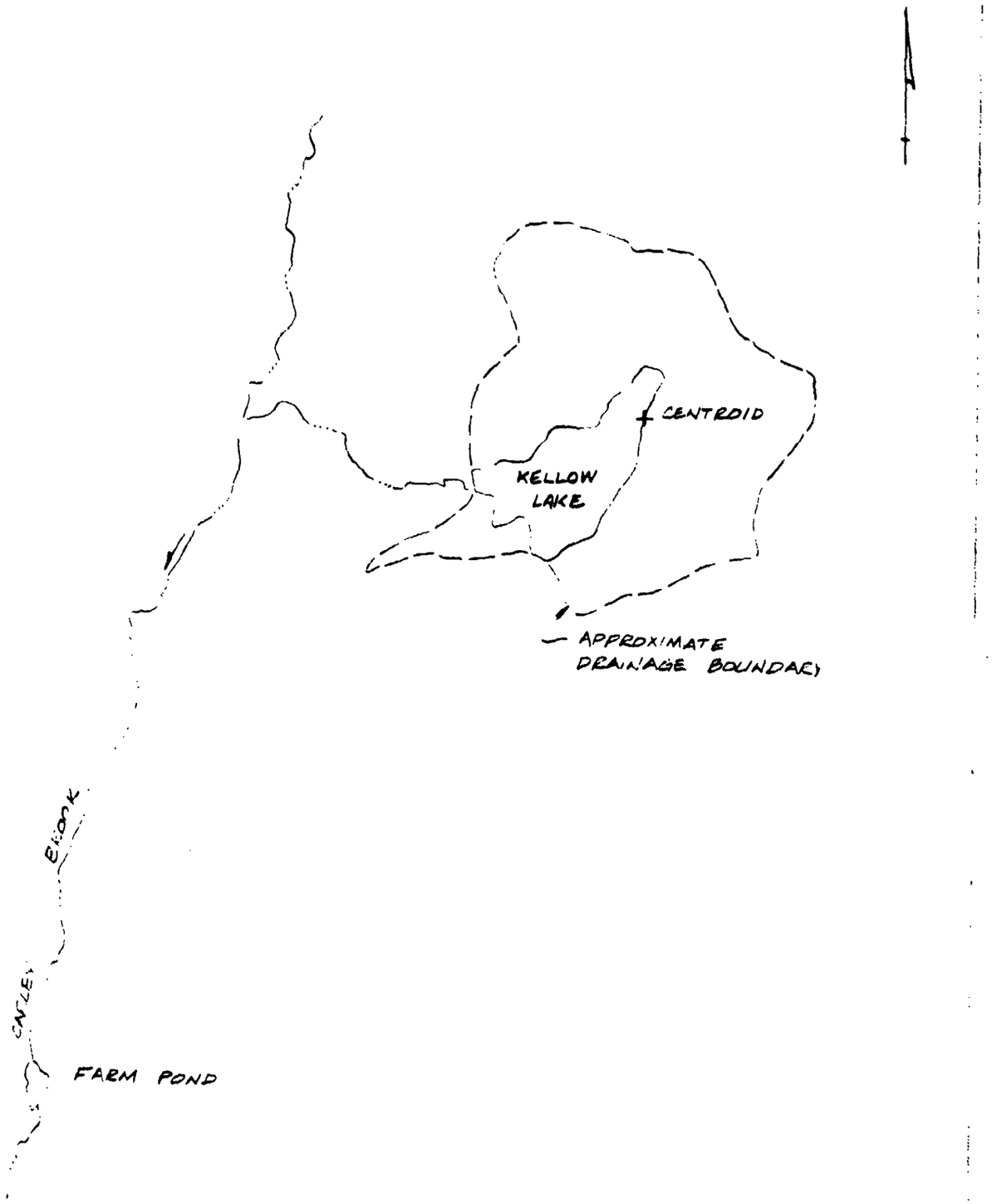
RAINFALL DATA:

PMF Rainfall Index= N/A in., 24 hr., 200 sq. mile

| | Hydromet. 40 (Susquehanna Basin) | Hydromet. 33 (Other Basins) |
|---|---|---|
| Zone: | N/A | 1 |
| Geographic Adjustment Factor: | N/A | 1.0 |
| Revised Index Rainfall: | N/A | 21.2 |

RAINFALL DISTRIBUTION (percent)

| Time | Percent |
|---|---|
| 6 hours | 111 |
| 12 hours | 123 |
| 24 hours | 133 |
| 48 hours | 142 |
| 72 hours | |
| 96 hours | |




SKETCH OF SYSTEM
NOT TO SCALE.

Data for Dam at Outlet of Subarea A-1 (See sketch on Sheet D-4)

Name of Dam: KELLOW LAKE DAM

STORAGE DATA:

| Elevation | Area (acres) | Storage million gals | Storage acre-ft | Remarks |
|---|---|---|---|---|
| 1414.1 =ELEV0* | 0 | 0 | 0 | D.S. Toe |
| 1426.0 =ELEV1 | 70 =A1 | 91 | 278 =S1 | Spillway Crest |
| 1440.0 ** | 87 | | | |

* ELEV0 = ELEV1 - $(3S_1/A_1)$

** Planimetered contour at least 10 feet above top of dam

Reservoir Area at Normal Pool is 18 percent of subarea watershed.

BREACH DATA: BREACH ANALYSIS NOT REQUIRED

See Appendix B for sections and existing profile of the dam.

Soil Type from Visual Inspection: _____

Maximum Permissible Velocity (Plate 28, EM 1110-2-1601) _____ fps
(from $Q = CLH^{3/2} = V \cdot A$ and depth = (2/3) x H) & A = L·depth

HMAX = $(4/9\ V^2/C^2)$ = _____ ft., C = ____ Top of Dam El.= ____

HMAX + Top of Dam El. = _____ = FAILEL
(Above is elevation at which failure would start)

Dam Breach Data:

BRWID = _____ ft (width of bottom of breach)
Z = _____ (side slopes of breach)
ELBM = _____ (bottom of breach elevation, minimum of zero storage elevation)
WSEL = _____ (normal pool elevation)
T FAIL= _____ mins = _____ hrs (time for breach to develop)

Data for Dam at Outlet of Subarea A-1

Name of Dam: KELLOW LAKE DAM

| SPILLWAY DATA: | STOPLOGS IN PLACE Existing Conditions | STOPLOGS IN PLACE Design Conditions |
|---|---|---|
| Top of Dam Elevation | 1430.2 | 1431.6 |
| Spillway Crest Elevation | 1428.4 | 1428.4 |
| Spillway Head Available (ft) | 1.8 | 3.2 |
| Type Spillway | Drop inlet with stoplog controls | |
| "C" Value - Spillway | 3.1 | 3.1 |
| Crest Length - Spillway (ft) | 6.0 | 6.0 |
| Spillway Peak Discharge (cfs) | 45 | 106 |
| Auxiliary Spillway Crest Elev. | N/A | N/A |
| Auxiliary Spill. Head Avail. (ft) | N/A | N/A |
| Type Auxiliary Spillway | N/A | |
| "C" Value - Auxiliary Spill. (ft) | N/A | N/A |
| Crest Length - Auxil. Spill. (ft) | N/A | N/A |
| Auxiliary Spillway Peak Discharge (cfs) | N/A | N/A |
| Combined Spillway Discharge (cfs) | 45 | 106 |

Spillway Rating Curve: See Sheets D-8 and D-9

| Elevation | Q Spillway (cfs) | Q Auxiliary Spillway (cfs) | Combined (cfs) |
|---|---|---|---|
| | | | |
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| OUTLET WORKS RATING: | Outlet 1 | Outlet 2 | Outlet 3 |
|---|---|---|---|
| Invert of Outlet | (N/A) | | |
| Invert of Inlet | | | |
| Type | | | |
| Diameter (ft) = D | | | |
| Length (ft) = L | | | |
| Area (sq. ft) = A | | | |
| N | | | |
| K Entrance | | | |
| K Exit | | | |
| K Friction=$29.1_N{}^2L/R^{4/3}$ | | | |
| Sum of K | | | |
| $(1/K)^{0.5}$ = C | | | |
| Maximum Head (ft) = HM | | | |
| Q = $CA\sqrt{2g(HM)}$(cfs) | | | |
| Q Combined (cfs) | | | |

Data for Dam at Outlet of Subarea A-1

Name of Dam: KELLOW LAKE DAM

| SPILLWAY DATA: | STOPLOGS REMOVED Existing Conditions | Design Conditions |
|---|---|---|
| Top of Dam Elevation | 1430.2 | |
| Spillway Crest Elevation | 1426.0 | |
| Spillway Head Available (ft) | 4.2 | |
| Type Spillway | Drop inlet | |
| "C" Value - Spillway | 3.1 | |
| Crest Length - Spillway (ft) | 3.5 | |
| Spillway Peak Discharge (cfs) | 93 | |
| Auxiliary Spillway Crest Elev. | N/A | |
| Auxiliary Spill. Head Avail. (ft) | N/A | |
| Type Auxiliary Spillway | N/A | |
| "C" Value - Auxiliary Spill. (ft) | N/A | |
| Crest Length - Auxil. Spill. (ft) | N/A | |
| Auxiliary Spillway Peak Discharge (cfs) | N/A | |
| Combined Spillway Discharge (cfs) | 93 | |

Spillway Rating Curve: See Sheet D-9

| Elevation | Q Spillway (cfs) | Q Auxiliary Spillway (cfs) | Combined (cfs) |
|---|---|---|---|
| | | | |
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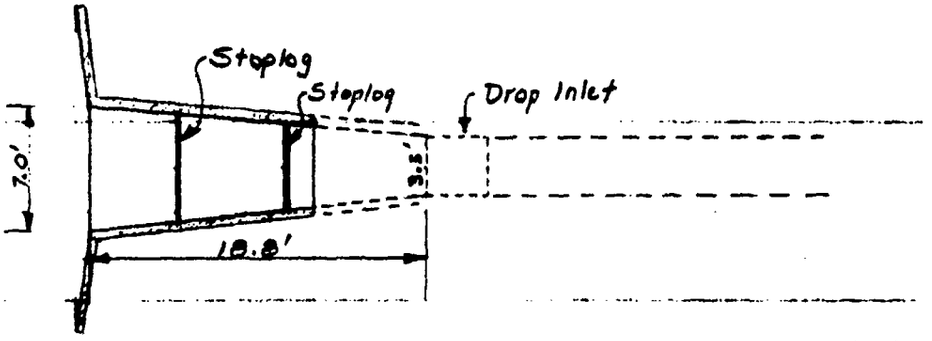
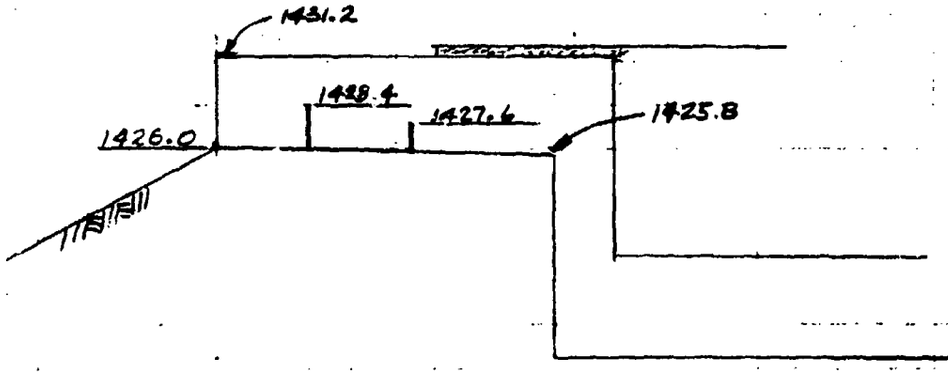
| OUTLET WORKS RATING: | Outlet 1 | Outlet 2 | Outlet 3 |
|---|---|---|---|
| Invert of Outlet | (N/A) | | |
| Invert of Inlet | | | |
| Type | | | |
| Diameter (ft) = D | | | |
| Length (ft) = L | | | |
| Area (sq. ft) = A | | | |
| N | | | |
| K Entrance | | | |
| K Exit | | | |
| K Friction=$29.1_N{}^2L/R^{4/3}$ | | | |
| Sum of K | | | |
| $(1/K)^{0.5} = C$ | | | |
| Maximum Head (ft) = HM | | | |
| $Q = CA\sqrt{2g(HM)}$ (cfs) | | | |
| Q Combined (cfs) | | | |

BY ___ DATE 6/16/81 SUBJECT Kellow Lake Dam SHEET NO. ___ OF ___
CHKD BY ___ DATE ___ Spillway Rating Curves JOB. NO. ___




Spillway Plan




Spillway Profile

Rating Curve with Stoplogs Removed

Use an approximate analysis assuming horizontal channel at El. 1426.0 with critical depth control at the drop inlet. Assume no energy losses occur and assume pressure flow does not occur.

$$Q = CLH^{3/2} = (3.1)(3.5)H^{3/2} = 10.85\,H^{3/2}$$

For pool level at top of dam (Elev. 1430.2):

$$Q_{max} = (10.85)(4.2)^{3/2} = 93 \text{ cfs}$$

BY _____ DATE 6/17/81 SUBJECT Kellow Lake Dam SHEET NO. _____ OF _____
CHKD. BY _____ DATE _____ Spillway Rating Curves JOB. NO. _____

Rating Curve with Stoplogs in Place

Assume discharge is controlled by upstream set of stoplogs. Check tailwater level created by downstream set of stoplogs.

Pool level at top of dam = El. 1430.2

For upstream stoplogs with no tailwater submergence:

$Q_{max} = (3.1)(6)(1430.2 - 1428.4)^{3/2} = 45$ cfs

Check tailwater level:

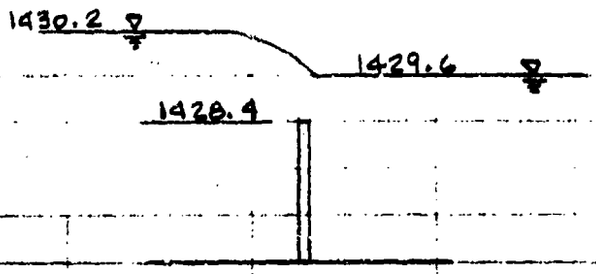
Width of channel at downstream stoplogs = 5'

$$d = \left(\frac{Q^2}{g b^2}\right)^{1/3} = \left(\frac{(45)^2}{(32.2)(5)^2}\right)^{1/3} = 1.4'$$

$A = bd = (5)(1.4) = 7\ ft^2$ $V = Q/A = 45/7 = 6.4$ ft/sec

$V^2/2g = 0.6$ ft

Tailwater level = 1427.6 + 1.4 + 0.6 = 1429.6




Check depth over stoplog ratio:

$1.2/1.8 = 2/3$

Since ratio = 2/3 for pool level at top of dam, submergence effects need not be considered. The spillway rating curve with the stoplogs in place can be based on control by the upstream set of stoplogs:

$Q = (3.1)(6)\,H^{3/2} = 18.6\,H^{3/2}$

BY _____ DATE _____ SUBJECT _____ SHEET NO. _____ OF _____

CHKD. BY _____ DATE _____ JOB. NO. _____

## Index of Selected Computer Output

```
**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
**********************************
    1                A1                                NATIONAL DAM INSPECTION PROGRAM
    2                A2                          BALTIMORE DISTRICT CORPS OF ENGINEERS
    3                A3                                    KELLOW LAKE DAM
    4                B     300        0       15        0        0        0        0        0       -4        0
    5                B1      5
    6                J       1        9        1
    7                J1    1.0      0.9      0.8      0.7      0.6      0.5      0.4      0.3      0.2
    8                K       0        1                                                   1
    9                K1        INFLOW TO KELLOW LAKE
   10                M       1        1      0.6                0.6                                 ;
   11                P                21.2      111      123      133      142
   12                T                                                             1.0     0.05              0.18
   13                W    0.82     0.45
   14                X    -1.5    -0.05      2.0
   15                K       1        1                                                   1
   16                K1        ROUTE THROUGH KELLOW LAKE
   17                Y                                          1        1
   18                Y1      1                                                  -1428.4        0
   19                SA      0       70       87
   20                SE1414.1  1426.0   1440.0
   21                SS1428.4     6.0      3.1      1.5
   22                SD1430.2
   23                SL      0      240      420      515
   24                SV1430.2  1431.0   1431.6   1434.0
   25                K      99
```

11-0

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

| OPERATION | STATION | AREA | PLAN | RATIOS APPLIED TO FLOWS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | RATIO 1 1.00 | RATIO 2 .90 | RATIO 3 .80 | RATIO 4 .70 | RATIO 5 .60 | RATIO 6 .50 | RATIO 7 .40 | RATIO 8 .30 | RATIO 9 .20 |
| HYDROGRAPH AT | 1 | .60 | 1 | 1844. | 1660. | 1475. | 1291. | 1107. | 922. | 738. | 553. | 369. |
| | | ( 1.55) | | ( 52.22)( | 47.00)( | 41.78)( | 36.56)( | 31.33)( | 26.11)( | 20.89)( | 15.67)( | 10.44) |
| ROUTED TO | 1 | .60 | 1 | 1571. | 1376. | 1163. | 950. | 740. | 528. | 312. | 11. | 39. |
| | | ( 1.55) | | ( 44.49)( | 38.97)( | 32.94)( | 26.91)( | 20.95)( | 14.96)( | 8.92)( | 3.35)( | 1.09) |

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ..............

| | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|
| ELEVATION | 1428.40 | 1428.40 | 1430.20 |
| STORAGE | 449. | 449. | 582. |
| OUTFLOW | 0. | 0. | 45. |

| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|---|---|---|---|---|---|---|---|
| 1.00 | 1431.94 | 1.74 | 714. | 1571. | 19.25 | 41.00 | 0.00 |
| .90 | 1431.85 | 1.65 | 707. | 1376. | 18.75 | 41.25 | 0.00 |
| .80 | 1431.73 | 1.53 | 698. | 1163. | 18.25 | 41.50 | 0.00 |
| .70 | 1431.60 | 1.40 | 688. | 950. | 17.25 | 41.50 | 0.00 |
| .60 | 1431.46 | 1.26 | 677. | 740. | 16.50 | 42.00 | 0.00 |
| .50 | 1431.29 | 1.09 | 664. | 528. | 15.50 | 42.50 | 0.00 |
| .40 | 1431.05 | .85 | 646. | 312. | 14.25 | 43.00 | 0.00 |
| .30 | 1430.68 | .48 | 618. | 118. | 12.25 | 44.00 | 0.00 |
| .20 | 1430.03 | 0.00 | 569. | 39. | 0.00 | 45.00 | 0.00 |

```
**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
**********************************
    1                A1                        NATIONAL DAM INSPECTION PROGRAM
    2                A2                  BALTIMORE DISTRICT CORPS OF ENGINEERS
    3                A3                             KELLOW LAKE DAM
    4                B     300       0       15       0       0       0       0       0      -4       0
    5                P1      5
    6                J       1       9       1
    7                J1    1.0     0.9     0.8     0.7     0.6     0.5     0.4     0.3     0.2
    8                K       0       1                                       1
    9                K1        INFLOW TO KELLOW LAKE
   10                M       1       1     0.6               0.6                             1
   11                P               21.2    111     123     133     142
   12                T                                                 1.0    0.05             0.18
   13                W    0.82    0.45
   14                X    -1.5   -0.05     2.0
   15                K       1       1                                       1
   16                K1        ROUTE THROUGH KELLOW LAKE
   17                Y                                       1       1
   18                Y1      1                                       -1429.4       0
   19                $A      0      70      87
   20                $E 1414.1  1426.0  1440.0
   21                $S 1428.4     6.0     3.1     1.5
   22                $D 1431.6
   23                $L    420     515
   24                $V 1431.6  1434.0
   25                K      99
```

D-14

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

| OPERATION | STATION | AREA | PLAN | RATIOS APPLIED TO FLOWS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | RATIO 1 1.00 | RATIO 2 .90 | RATIO 3 .80 | RATIO 4 .70 | RATIO 5 .60 | RATIO 6 .50 | RATIO 7 .40 | RATIO 8 .30 | RATIO 9 .20 |
| HYDROGRAPH AT | 1 | .60 | 1 | 1844. | 1660. | 1475. | 1291. | 1107. | 922. | 738. | 553. | 369. |
| | ( | 1.55) | ( | 52.22)( | 47.00)( | 41.78)( | 36.56)( | 31.33)( | 26.11)( | 20.89)( | 15.67)( | 10.44) |
| ROUTED TO | 1 | .60 | 1 | 1498. | 1276. | 1052. | 827. | 602. | 337. | 101. | 68. | 39. |
| | ( | 1.55) | ( | 42.43)( | 36.14)( | 29.80)( | 23.43)( | 17.05)( | 9.55)( | 2.86)( | 1.92)( | 1.09) |

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ..............

| | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|
| ELEVATION | 1428.40 | 1428.40 | 1431.60 |
| STORAGE | 449. | 449. | 658. |
| OUTFLOW | 0. | 0. | 106. |

| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|---|---|---|---|---|---|---|---|
| 1.00 | 1432.60 | 1.00 | 765. | 1498. | 8.50 | 41.25 | 0.00 |
| .90 | 1432.49 | .89 | 757. | 1276. | 8.00 | 41.50 | 0.00 |
| .80 | 1432.37 | .77 | 747. | 1052. | 7.50 | 41.75 | 0.00 |
| .70 | 1432.24 | .64 | 738. | 827. | 7.00 | 42.00 | 0.00 |
| .60 | 1432.10 | .50 | 727. | 602. | 6.25 | 42.50 | 0.00 |
| .50 | 1431.90 | .30 | 711. | 337. | 5.00 | 43.25 | 0.00 |
| .40 | 1431.49 | 0.00 | 680. | 101. | 0.00 | 44.50 | 0.00 |
| .30 | 1430.77 | 0.00 | 625. | 68. | 0.00 | 44.75 | 0.00 |
| .20 | 1430.03 | 0.00 | 569. | 39. | 0.00 | 45.00 | 0.00 |

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
**********
```

```
    1                A1                          NATIONAL DAM INSPECTION PROGRAM
    2                A2                  BALTIMORE DISTRICT CORPS OF ENGINEERS
    3                A3                              KELLOW LAKE DAM
    4                B     300        0       15        0        0        0        0       -4        0
    5                B1      5
    6                J       1        9        1
    7                J1    1.0      0.9      0.8      0.7      0.6      0.5      0.4      0.3      0.2
    8                K       0        1                                          1
    9                K1        INFLOW TO KELLOW LAKE
   10                M       1        1      0.6                0.6                                 1
   11                P                21.2      111      123      133      142
   12                T                                                    1.0     0.05                0.18
   13                W    0.82     0.45
   14                X    -1.5    -0.05      2.0
   15                K       1        1                                          1
   16                K1        ROUTE THROUGH KELLOW LAKE
   17                Y                                          1        1
   18                Y1      1                                                -1426.0        0
   19                SA      0       70       87
   20                SE1414.1 1426.0  1440.0
   21                SS1426.0     3.5      3.1      1.5
   22                SD1430.2
   23                SL      0      240      420      515
   24                SV1430.2 1431.0  1431.6  1434.0
   25                K      99
```

D-17

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

| OPERATION | STATION | AREA | PLAN | RATIOS APPLIED TO FLOWS RATIO 1 1.00 | RATIO 2 .90 | RATIO 3 .80 | RATIO 4 .70 | RATIO 5 .60 | RATIO 6 .50 | RATIO 7 .40 | RATIO 8 .30 | RATIO 9 .20 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HYDROGRAPH AT | 1 | .60 | 1 | 1844. | 1660. | 1475. | 1291. | 1107. | 922. | 738. | 553. | 369. |
| | ( | 1.55) | ( | 52.22)( | 47.00)( | 41.78)( | 36.56)( | 31.33)( | 26.11)( | 20.89)( | 15.67)( | 10.44) |
| ROUTED TO | 1 | .60 | 1 | 1172. | 944. | 700. | 435. | 203. | 92. | 65. | 45. | 25. |
| | ( | 1.55) | ( | 33.19)( | 26.74)( | 19.82)( | 12.32)( | 5.74)( | 2.61)( | 1.92)( | 1.28)( | .72) |

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ..............

| | INITIAL VALUE | SPILLWAY CREST | TOP OF DAM |
|---|---|---|---|
| ELEVATION | 1426.00 | 1426.00 | 1430.20 |
| STORAGE | 278. | 278. | 582. |
| OUTFLOW | 0. | 0. | 93. |

| RATIO OF PMF | MAXIMUM RESERVOIR W.S.ELEV | MAXIMUM DEPTH OVER DAM | MAXIMUM STORAGE AC-FT | MAXIMUM OUTFLOW CFS | DURATION OVER TOP HOURS | TIME OF MAX OUTFLOW HOURS | TIME OF FAILURE HOURS |
|---|---|---|---|---|---|---|---|
| 1.00 | 1431.72 | 1.52 | 697. | 1172. | 12.75 | 42.00 | 0.00 |
| .90 | 1431.58 | 1.38 | 686. | 944. | 12.25 | 42.50 | 0.00 |
| .80 | 1431.40 | 1.20 | 673. | 700. | 11.50 | 42.75 | 0.00 |
| .70 | 1431.15 | .95 | 654. | 435. | 10.75 | 43.25 | 0.00 |
| .60 | 1430.78 | .58 | 626. | 203. | 9.00 | 44.25 | 0.00 |
| .50 | 1430.16 | 0.00 | 579. | 92. | 0.00 | 45.00 | 0.00 |
| .40 | 1429.39 | 0.00 | 521. | 68. | 0.00 | 45.25 | 0.00 |
| .30 | 1428.59 | 0.00 | 463. | 45. | 0.00 | 45.50 | 0.00 |
| .20 | 1427.77 | 0.00 | 403. | 25. | 0.00 | 45.75 | 0.00 |

BY _____ DATE _____ SUBJECT _____ SHEET NO. _____ OF _____

CHKD. BY _____ DATE _____ JOB. NO. _____

# Kellow Lake Dam
## Summary of Pertinent Results

PMF Rainfall = 24.08 inches PMF Runoff = 22.13 inches

½ PMF Rainfall = 12.04 inches ½ PMF Runoff = 11.06 inches

Case 1: Pool El. = 1428.4 Top of Dam El. = 1430.2

| | PMF | ½ PMF |
|---|---|---|
| Peak inflow (cfs) | 1,844 | 922 |
| Peak outflow (cfs) | 1,571 | 528 |
| Depth of overtopping (ft) | 1.74 | 1.09 |
| Duration of overtopping (hr) | 19.25 | 15.50 |

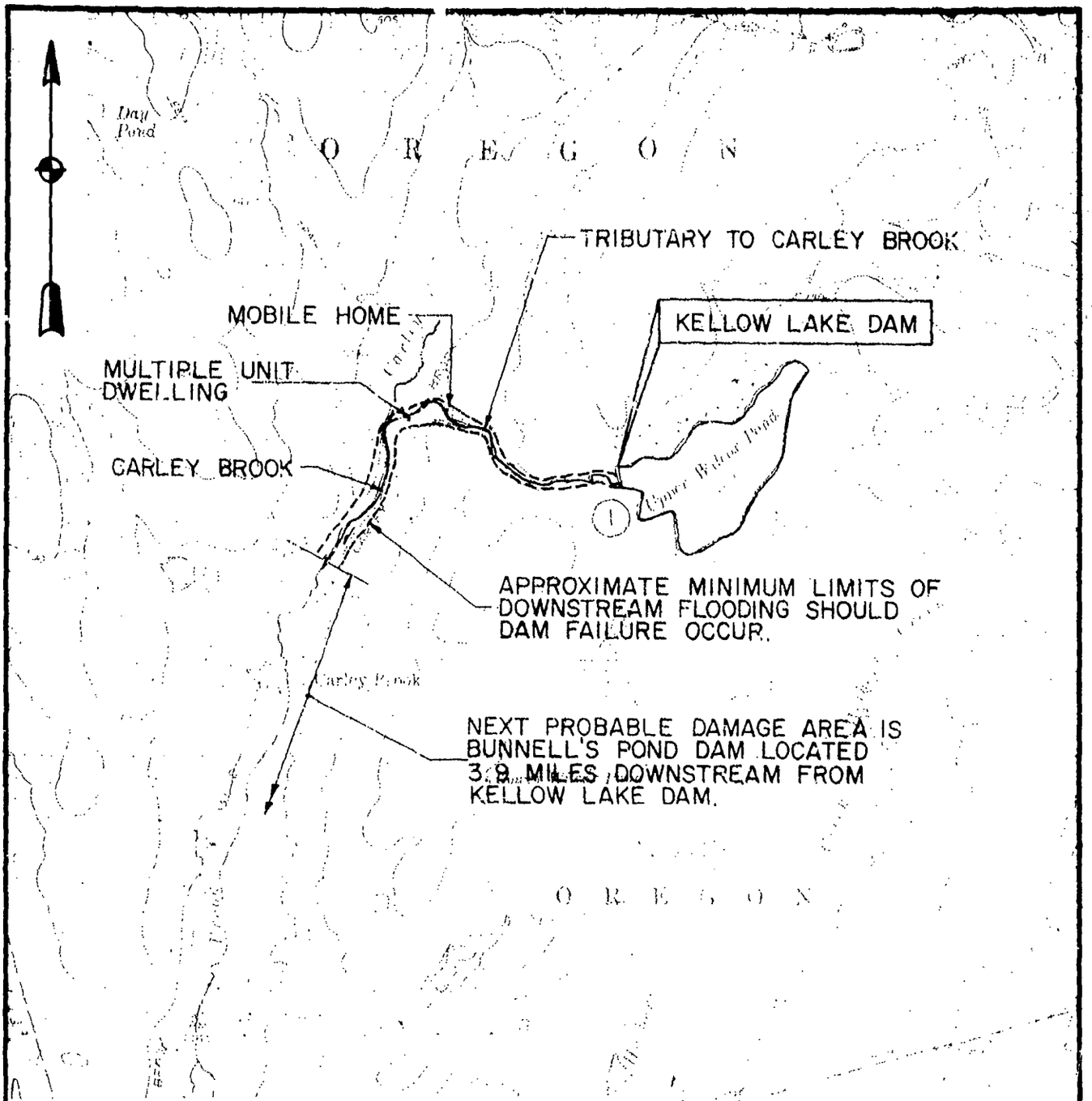
Case 2: Pool El. = 1428.4 Top of Dam El. = 1431.6

| | PMF | ½ PMF |
|---|---|---|
| Peak inflow (cfs) | 1,844 | 922 |
| Peak outflow (cfs) | 1,498 | 337 |
| Depth of overtopping (ft) | 1.00 | 0.30 |
| Duration of overtopping (hr) | 8.50 | 5.00 |

Case 3: Pool El. = 1426.0 Top of Dam El. = 1430.2

| | PMF | ½ PMF |
|---|---|---|
| Peak inflow (cfs) | 1,844 | 922 |
| Peak outflow (cfs) | 1,172 | 92 |
| Depth of overtopping (ft) | 1.52 | 0.00 |
| Duration of overtopping (hr) | 12.75 | 0.00 |

Note: Minimum SDF for Kellow Lake Dam = ½ PMF




**NOTES:**

1. LIMITS OF DOWNSTREAM FLOODING ARE ESTIMATES BASED ON VISUAL OBSERVATIONS.
2. CIRCLED NUMBERS INDICATE STATIONS USED IN COMPUTER ANALYSIS.
3. THIS MAP SHOULD NOT BE USED IN CONNECTION WITH THE EMERGENCY OPERATION AND WARNING PLAN.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

KELLOW LAKE DAM

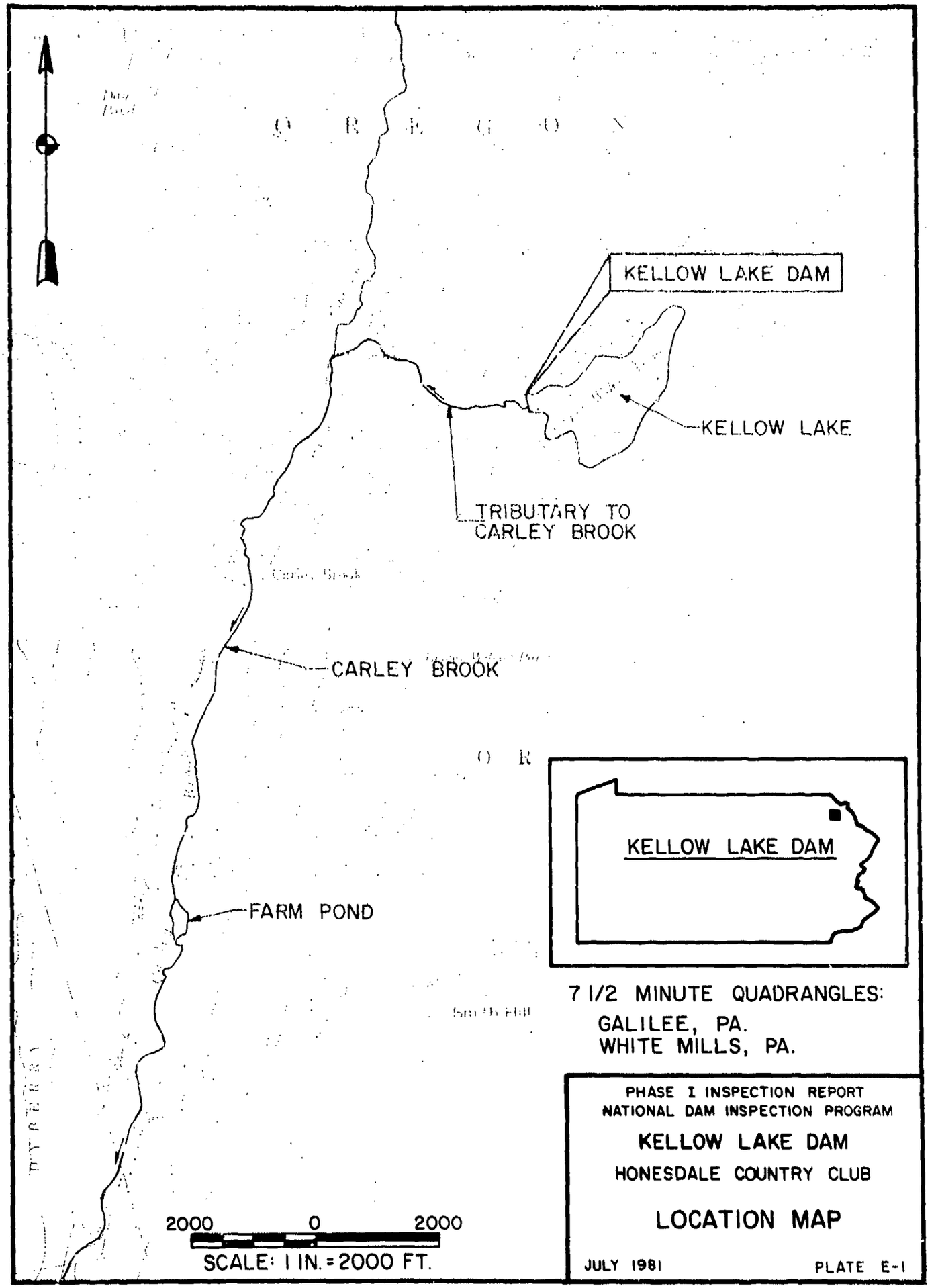
HONESDALE COUNTRY CLUB

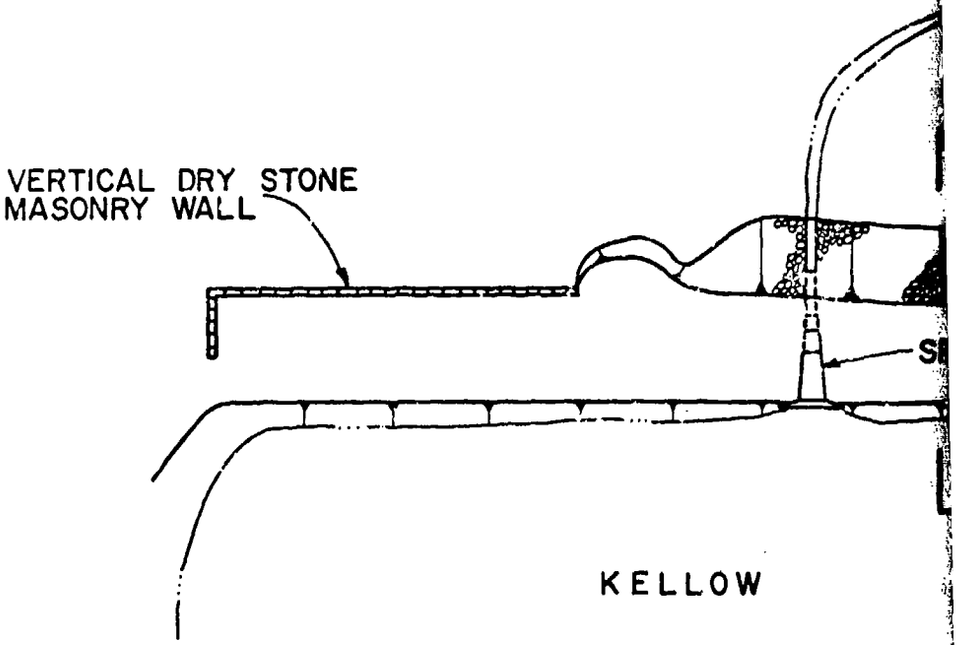
# DOWNSTREAM DEVELOPMENT PLAN

JULY 1981 EXHIBIT D-1

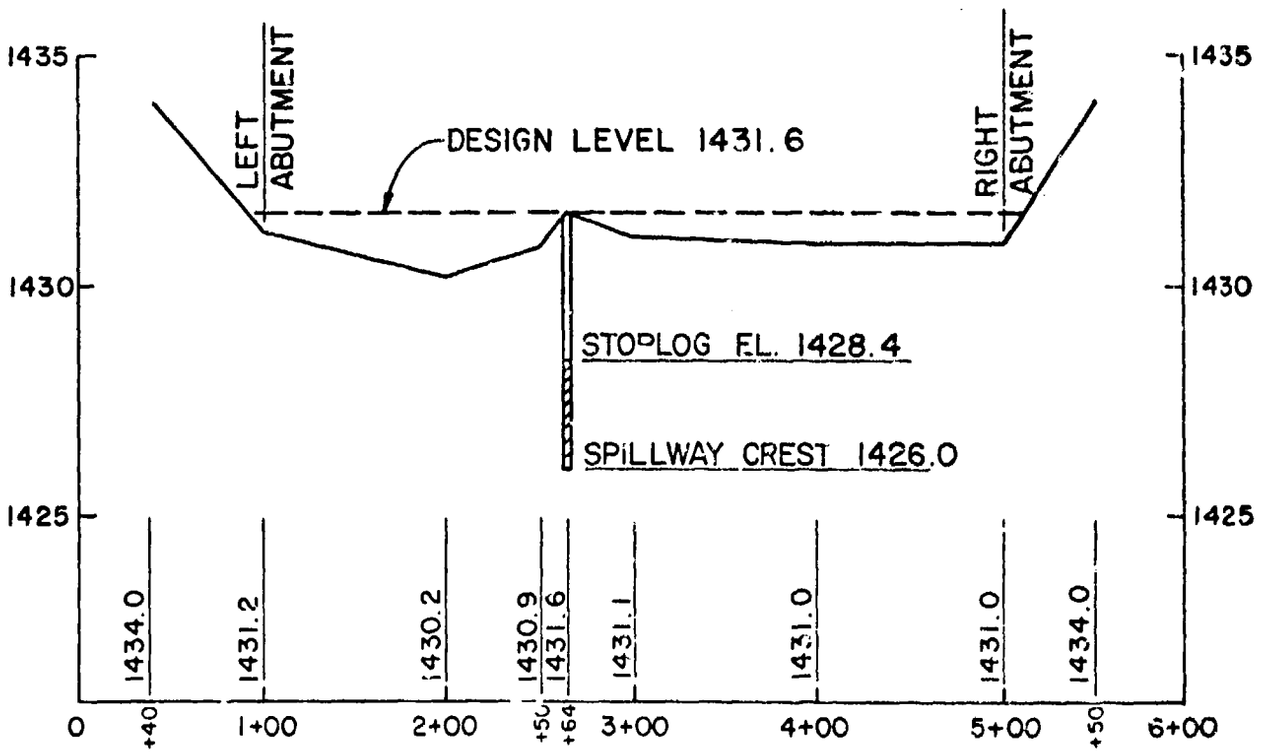
# APPENDIX E

# PLATES


KELLOW LAKE DAM
KELLOW LAKE
TRIBUTARY TO
CARLEY BROOK
CARLEY BROOK
FARM POND
2000 0 2000
SCALE: 1 IN. = 2000 FT.
KELLOW LAKE DAM
7 1/2 MINUTE QUADRANGLES:
GALILEE, PA.
WHITE MILLS, PA.
PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
KELLOW LAKE DAM
HONESDALE COUNTRY CLUB
LOCATION MAP
JULY 1981
PLATE E-1

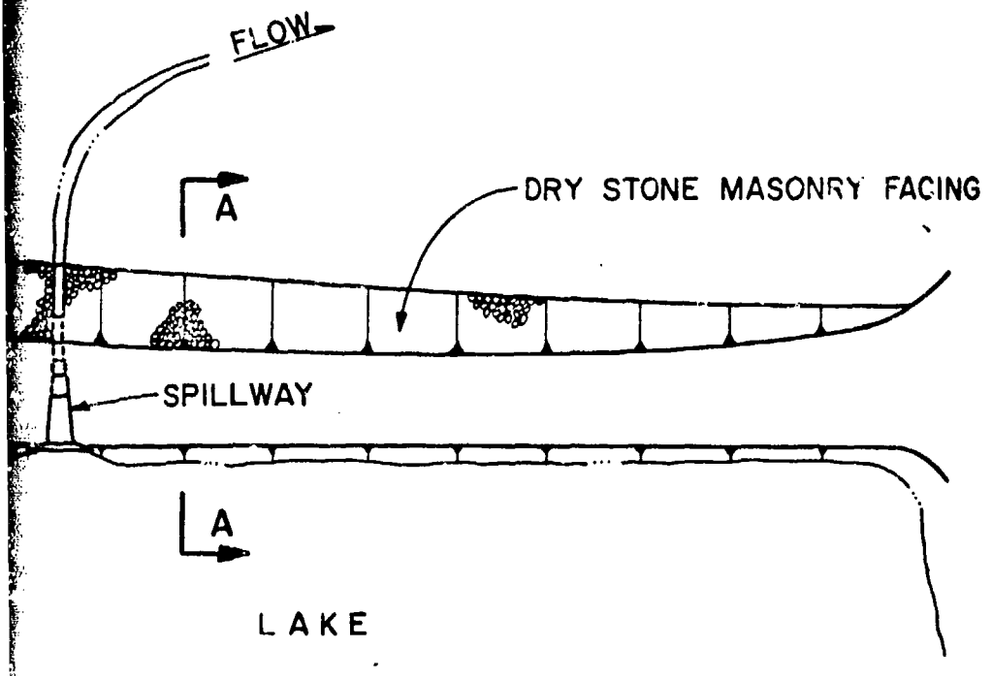



SKETCH
NOT TO

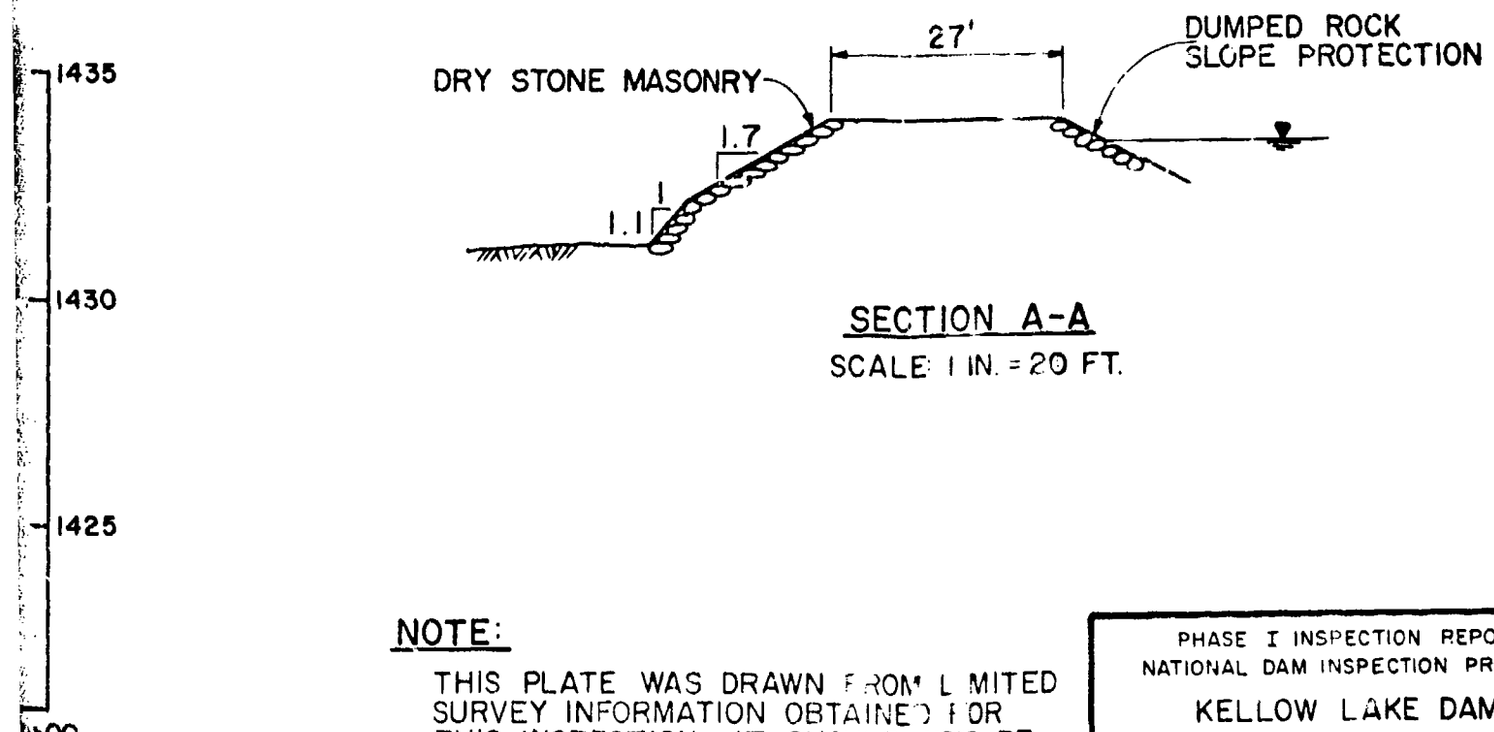



PROFILE-TOP OF DAM

SCALE: HORIZ. - 1 IN. = 100 FT.
VERT. - 1 IN. = 4 FT.




SKETCH OF DAM
NOT TO SCALE




SECTION A-A
SCALE: 1 IN. = 20 FT.

NOTE:

THIS PLATE WAS DRAWN FROM LIMITED SURVEY INFORMATION OBTAINED FOR THIS INSPECTION; IT SHOULD NOT BE CONSIDERED DEFINITIVE.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
KELLOW LAKE DAM
HONESDALE COUNTRY CLUB
PLAN, PROFILE
AND SECTION
JULY 1981 PLATE E-2

# APPENDIX F

# GEOLOGY

# KELLOW LAKE DAM

## APPENDIX F

## GEOLOGY

Kellow Lake Dam is located in Wayne County within the Appalachian Plateau Physiographic Province. The most pronounced topographic feature in the area is Camelback Mountain, which is part of the Pocono Plateau Escarpment. The escarpment has a well defined, southwestward trend from Camelback Mountain, but it is irregular between Camelback Mountain and Mt. Pocono, which lies to the north. Streams east of the escarpment drain directly to the Delaware River, while those to the west drain to the Lehigh River.

The Pocono Plateau Section lies to the west of the escarpment. This area is relatively flat, with local relief seldom exceeding 100 feet. The topography has been greatly influenced by continental glaciation. Many features were created by deposition of glacial materials. The entire plateau lacks well-developed drainage.

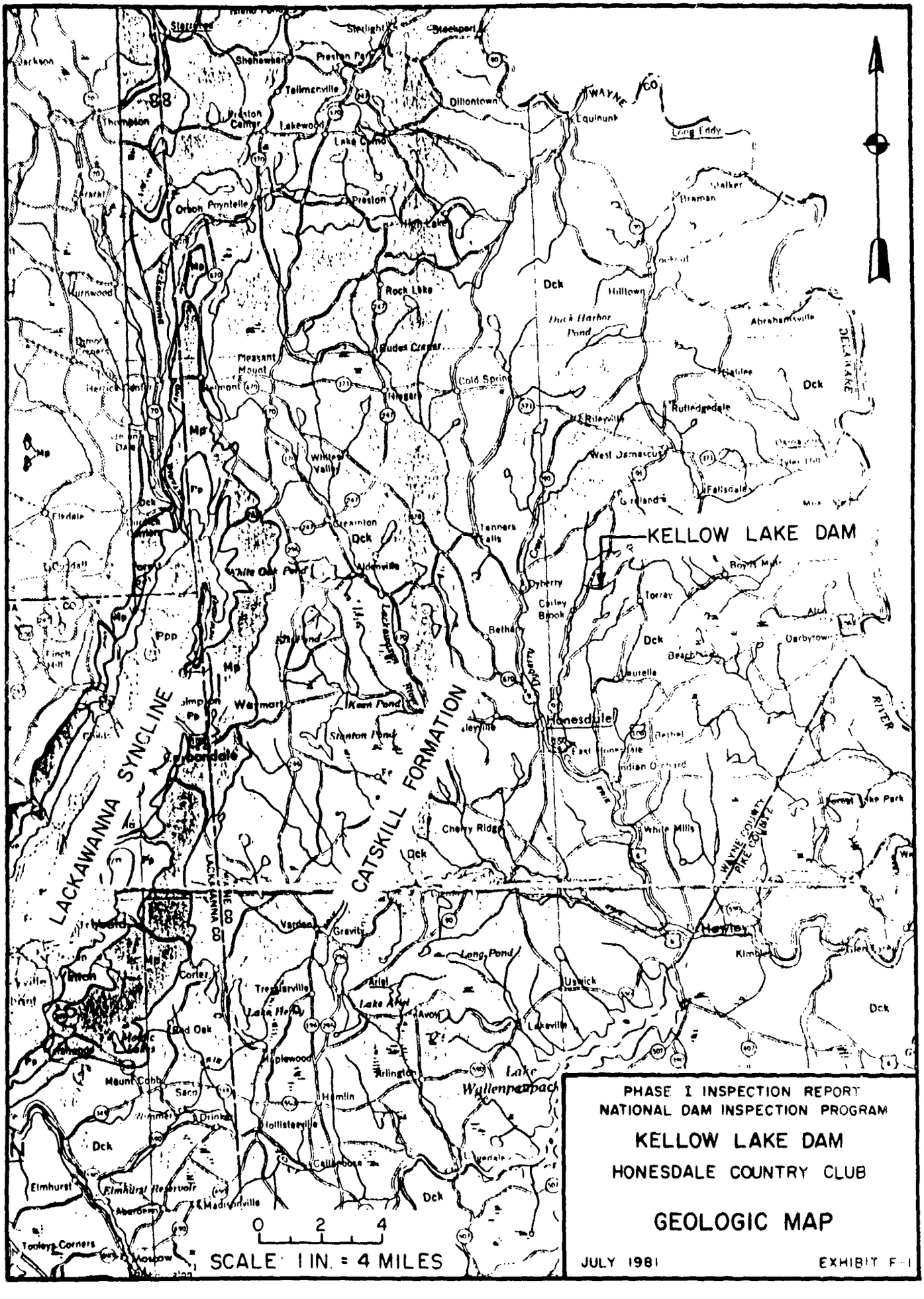
East of the escarpment is the Glaciated Low Plateaus Section of the province. This area is characterized by preglacial erosional topography within locally-thick glacial deposits. Local relief is generally 100 to 300 feet.

Bedrock units of the sections described above are the lithified sediments of offshore marine, marginal marine, deltaic environments, and fluvial environments associated with the Devonian Period. These units include siltstones of the Mahantango Formation, siltstones and shales of the Trimmers Rock Formation, and seven mapped members of the Catskill Formation. These members include sandstones, siltstones, and shales of the Towamensing Member; sandstone, siltstone and shale of the Walcksville Member; sandstones, siltstones and shale of the Beaverdam Run Member; sandstone and shale in the Long Run Member; sandstones and conglomerates in the Packerton Member; sandstones and some conglomerates in the Poplar Gap Member; and sandstones and conglomerates in the Duncannon Member.

Kellow Lake Dam is underlain by The Catskill Formation. The Catskill Formation is predominantly red to brownish gray shales and sandstone with interbedded siltstones and conglomerates. Sandstones present are thick-bedded, fine- to coarse-grained and exhibit very low primary porosity due to a clay and silica matrix. Effective porosity results from fractures and parting planes.

The rocks are well-indurated and generally are not susceptible to slope failure; however, the presence of well-developed bedding and joint planes will result in some rockfall from vertical and high-angle cut slopes.

Bedrock is entirely overlain by glacial till of Late Wisconsin Age. This till is an unsorted mixture of clay, silt, sand, and gravel. It is moderately cohesive and is generally derived locally from the sandstones of the Catskill Formation. Thickness of the till varies from 5 to 75 feet.




PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

# KELLOW LAKE DAM

HONESDALE COUNTRY CLUB

## GEOLOGIC MAP

JULY 1981

EXHIBIT F-1